CLAIMS

The invention claimed is:

1. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing three components of the Earth's magnetic field vector, and for generating output signals representing the three sensed components;

a pitch and roll sensing circuit for measuring the pitch and roll of the magnetic sensor circuit; and

a processing circuit coupled to said magnetic sensor circuit and said pitch and roll sensing circuit for receiving the output signals, compensating the sensed components for the measured pitch and roll, computing a heading of the vehicle as a function of at least two of the compensated sensed components, and generating a heading signal representing the computed heading.

2. The electronic compass system of claim 1, wherein the following formulas are used to compensate the sensed components (Hx, Hy, Hz) for the measured pitch (*pitch*) and roll (*roll*) by performing a coordinate transformation, such that the compensated sensed components (Hex, Hey, Hez) are:

$$Hex = Hx*\cos(pitch) - Hy*\sin(roll)\sin(pitch) - Hz*\cos(roll)\sin(pitch)$$

$$Hey = Hy*\cos(roll) - Hz*\sin(roll)$$

$$Hez = Hx*\sin(pitch) + Hy*\sin(roll)\cos(pitch) - Hz*\cos(roll)\sin(pitch).$$

3. The electronic compass system of claim 1, wherein said pitch and roll sensing circuit is an accelerometer having output signals converted to an acceleration that varies between -1g and +1g, wherein the output signals are converted into the measured pitch and roll expressed in degrees by:

$$pitch = \mathrm{asin}(Ax/1g)$$

$$roll = \mathrm{asin}(Ay/1g).$$

4. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

determining a relative strength of the Earth's magnetic field vector,

determining whether too much noise is present in the output signals received from said magnetic sensor circuit as a function of the relative strength of the Earth's magnetic field vector,

if there is not too much noise present in the output signals, computing a heading of the vehicle as a function of the sensed components, and

generating a heading signal representing the computed heading or a prior heading if too much noise is present in the output signals.

5. The electronic compass system of claim 4, wherein said processing circuit determines whether too much noise is present in the output signals received from said magnetic sensor circuit when the variation in the output signals exceeds a threshold noise level.

6. The electronic compass system of claim 5 wherein said processing circuit further determines whether too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system, said processing circuit does not update the data used to calibrate the compass system when too much noise is present.

7. The electronic compass system of claim 6, wherein said processing circuit:

determines that too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system when the variation in the output signals exceeds the threshold noise level, and

determines that too much noise is present in the output signals received from said magnetic sensor circuit to update the heading signal when a defined time period has not yet elapsed from when the variation in the output signals last exceeded the threshold noise level.

8. The electronic compass system of claim 7, wherein the time period that must elapse before the heading signal can be updated is set as a function of the strength of the Earth's magnetic field.

9. The electronic compass system of claim 7, wherein the threshold noise level is set as a function of the Earth's magnetic field.

10. The electronic compass system of claim 4, wherein said processing circuit further determines whether too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system, said processing circuit does not update the data used to calibrate the compass system when too much noise is present.

11. The electronic compass system of claim 10, wherein said processing circuit determines whether too much noise is present in the output signals received from said magnetic sensor circuit to update data used to calibrate the compass system when the variation in the output signals exceeds a threshold noise level.

12. An electronic compass assembly for a vehicle, comprising:

a circuit board defining a plane corresponding to a mounting surface thereof;

a magnetic sensor circuit mounted on said circuit board for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components, wherein said magnetic sensor circuit includes at least two magnetic field sensing elements each having an axis of sensitivity, wherein at least one of said magnetic field sensing elements is positioned such that its axis of sensitivity is oriented in one of the following two orientations: (a) non-perpendicular and non-parallel to the plane of said

circuit board, and (b) non-perpendicular to the axis of sensitivity of another one of said at least two magnetic field sensing elements; and

a processing circuit coupled to said magnetic sensor circuit for receiving the output signals, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading.

13. The electronic compass assembly of claim 12, wherein said magnetic compass sensor circuit includes three magnetic field sensing elements none of which are perpendicular or parallel to the plane of said circuit board.

14. The electronic compass assembly of claim 12, wherein said magnetic sensor circuit includes three magnetic field sensing elements contained in a common integrated package having a plurality of leads extending therefrom for mounting to said circuit board

15. The electronic compass assembly of claim 12, wherein said processing circuit performs a coordinate transform to account for the positioning of at least one of said magnetic field sensing elements such that its axis of sensitivity is oriented in one of the following two orientations: (a) non-perpendicular and non-parallel to the plane of said circuit board, and (b) non-perpendicular to the axis of sensitivity of another one of said at least two magnetic field sensing elements.

16. The electronic compass assembly of claim 15, wherein said processing circuit performs a coordinate transform of an original reference frame S having an x-axis, a y-axis, and a z-axis by:

(a) rotation of the original reference frame S by an angle α about the x-axis into a reference frame S' having an x'-axis, a y'-axis, and a z'-axis;

(b) rotation of the reference frame S' by an angle β about the y'-axis into a reference frame S" having an x"-axis, a y"-axis, and a z"-axis; and

(c) rotation of the reference frame S" by an angle γ about the z"-axis into reference coordinate frame S"'.

17. The electronic compass assembly of claim 16, wherein said processing circuit performs the coordinate transform using the following linear equation:

$$\begin{vmatrix} Xm \\ Ym \\ Zm \end{vmatrix} = \begin{vmatrix} \cos(\alpha)\cos(\beta)\cos(\gamma) - \sin(\alpha)s(\gamma) & \cos(\beta)\cos(\gamma)s(\alpha) + \cos(\alpha)\sin(\gamma) & -\cos(\gamma)\sin(\beta) \\ -\cos(\gamma)\sin(\alpha) - \cos(\alpha)c(\beta)\sin(\gamma) & \cos(\alpha)c(\gamma) - \cos(\beta)s(\alpha)\sin(\gamma) & \sin(\beta)\sin(\gamma) \\ \cos(\alpha)\sin(\beta) & \sin(\alpha)\sin(\beta) & \cos(\beta) \end{vmatrix} \begin{vmatrix} Xs \\ Ys \\ Zs \end{vmatrix}$$

18. A rearview mirror assembly for a vehicle, comprising:

a mirror mounting structure configured to mounting to a vehicle and having a mirror housing;

a mirror mounted in said mirror housing;

a circuit board carried by said mirror mounting structure;

a magnetic sensor circuit mounted on said circuit board for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components, wherein said magnetic sensor circuit includes three magnetic field sensing elements contained in a common integrated package having a plurality of leads extending therefrom for mounting to said circuit board; and

a processing circuit coupled to said magnetic sensor circuit for receiving the output signals from said magnetic sensor circuit, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading.

19. The rearview mirror assembly of claim 18, wherein said circuit board defines a plane corresponding to a mounting surface thereof, wherein each of said magnetic field sensing elements has an axis of sensitivity, and wherein at least one of said magnetic field sensing elements is positioned such that its axis of sensitivity is oriented in one of the following two orientations: (a) non-perpendicular and non-parallel to the plane of said circuit board, and (b) non-perpendicular to the axis of sensitivity of another one of said at least two magnetic field sensing elements.

20. An electronic compass subassembly for a vehicle, comprising:

a circuit board including a connector for connecting an electrical component; and

a processing circuit mounted on said on said circuit board and electrically coupled to said connector for communicating with the electrical component, wherein said processing circuit is coupled to a magnetic sensor circuit for receiving output signals representing at least two components of the Earth's magnetic field vector, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading,

wherein said processing circuit is configured to communicate using at least two different signal formats associated with different types of electronic components, and wherein a particular signal format used by said processing circuit to communicate with the electrical component connected to said connector is selectable.

21. The electronic compass subassembly of claim 20, wherein said electronic component is a display driver circuit.

22. The electronic compass subassembly of claim 21, wherein said display driver circuit is mounted on a daughter circuit board, said circuit boards each comprising a connector that electrically couples said circuit boards.

23. The electronic compass subassembly of claim 22, wherein said connector of said daughter circuit board has a connector configuration that is unique for the type of display driver circuit mounted thereon.

24. The electronic compass subassembly of claim 23, wherein said processing circuit automatically selects the particular signal format used to communicate with said display driver circuit based upon the connector configuration of the connector of said daughter circuit board.

25. The electronic compass subassembly of claim 20, wherein electronic component is mounted on a daughter circuit board, said circuit boards each comprising a connector that electrically couples said circuit boards.

26. The electronic compass subassembly of claim 25, wherein said connector of said daughter circuit board has a connector configuration that is unique for the type of electronic component mounted thereon.

27. The electronic compass subassembly of claim 26, wherein said processing circuit automatically selects the particular signal format used to communicate with said electronic component based upon the connector configuration of the connector of said daughter circuit board.

28. The electronic compass subassembly of claim 20, wherein said electronic component is a vehicle bus interface circuit.

29. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components;

a processing circuit coupled to said magnetic sensor circuit for receiving the output signals from said magnetic sensor circuit, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading; and

a display coupled to said processing circuit for receiving said heading signal and displaying the computed heading, said display further configured to display a geographical representation of at least one geographic region and a geographic magnetic variance zone within the geographic region for which the compass is presently calibrated.

30. The electronic compass system of claim 29, wherein the geographic magnetic variance zone displayed on said display is a time zone in which the vehicle is located.

31. The electronic compass system of claim 30, wherein said processing circuit is coupled to a vehicle electrical component for receiving information from which the time zone in which the vehicle is located may be identified.

32. The electronic compass system of claim 31, wherein said vehicle electrical component is an RDS radio.

33. The electronic compass system of claim 31, wherein said vehicle electrical component is a GPS receiver.

34. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components;

a processing circuit coupled to said magnetic sensor circuit for receiving the output signals from said magnetic sensor circuit, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading; and

a display coupled to said processing circuit for receiving said heading signal and displaying the computed heading, said display further configured to display a time zone for which the compass is presently calibrated.

35. The electronic compass system of claim 34, wherein said processing circuit is coupled to a vehicle electrical component for receiving information from which the time zone in which the vehicle is located may be identified.

36. The electronic compass system of claim 35, wherein said vehicle electrical component is an RDS radio.

37. The electronic compass system of claim 35, wherein said vehicle electrical component is a GPS receiver.

38. The electronic compass system of claim 34, wherein said display is a graphic display displaying a geographical representation of a geographic region and its various time zones.

39. The electronic compass system of claim 34, wherein said display is an alphanumeric display.

40. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for receiving the output signals from said magnetic sensor circuit, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading,

wherein said processing circuit is coupled to a vehicle electrical component to receive an indication of a time zone in which the vehicle is presently traveling, said processing circuit compensates the heading computation as a function of geographic magnetic variance for the time zone in which the vehicle is presently traveling.

41. The electronic compass system of claim 40, wherein said vehicle electrical component is an RDS radio.

42. The electronic compass system of claim 40, wherein said vehicle electrical component is a GPS receiver.

43. The electronic compass system of claim 40, wherein said processing circuit is further adapted for:

storing historical samples of the computed heading at periodic intervals,

analyzing the stored historical samples to determine at which four sets of values of the sensed components that the vehicle travels most frequently,

computing a variance of the four sets of values of the sensed components that the vehicle travels most frequently from the four sets of values of the sensed components that the processing circuit had identified as corresponding to headings of north, south, east, and west, and

compensating the heading computation as a function of the computed variance.

44. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

computing a heading of the vehicle as a function of the sensed components,

generating a heading signal representing the computed heading,

storing historical samples of the computed heading at periodic intervals,

analyzing the stored historical samples to determine at which four sets of values of the sensed components that the vehicle travels most frequently,

computing a variance of the four sets of values of the sensed components that the vehicle travels most frequently from the four sets of values of the sensed components that the processing circuit had identified as corresponding to headings of north, south, east, and west, and

compensating the heading computation as a function of the computed variance.

45. The electronic compass system of claim 44, wherein said magnetic sensor circuit is mounted in a mirror housing of a rearview mirror assembly of the vehicle, and wherein the

compensation performed by said processing circuit compensates for rotation of the mirror housing relative to the vehicle.

46. The electronic compass system of claim 44, wherein the compensation performed by said processing circuit compensates for geographic magnetic variance.

47. The electronic compass system of claim 44, wherein, when storing historical samples and analyzing the stored historical samples, said processing circuit excludes samples corresponding to headings traveled before or following a turn that is not equal to approximately a 90 degree turn.

48. The electronic compass system of claim 44, wherein, when storing historical samples and analyzing the stored historical samples, said processing circuit gives less weight to samples obtained before and after the first detected heading change occurring during an ignition cycle.

49. The electronic compass system of claim 44, wherein, when storing historical samples and analyzing the stored historical samples, said processing circuit gives less weight to samples obtained before and after the last detected heading change occurring during an ignition cycle.

50. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

computing a noise level from the output signals received from said magnetic sensor circuit as a function of a root mean square of values derived from the output signals,

determining whether too much noise is present in the output signals received from said magnetic sensor circuit if the noise level exceeds a threshold noise level,

if there is not too much noise present in the output signals, computing a heading of the vehicle as a function of the sensed components, and

generating a heading signal representing the computed heading or a prior heading if too much noise is present in the output signals.

51. The electronic compass system of claim 50, wherein said processing circuit computes second derivatives of the output signals from said compass sensor circuit, and wherein said processing circuit computes the noise level as a function of the root mean square of the computed second derivatives.

52. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

computing a noise level from the output signals received from said magnetic sensor circuit as a function of a mean square error of values derived from the output signals,

determining whether too much noise is present in the output signals received from said magnetic sensor circuit if the noise level exceeds a threshold noise level,

if there is not too much noise present in the output signals, computing a heading of the vehicle as a function of the sensed components, and

generating a heading signal representing the computed heading or a prior heading if too much noise is present in the output signals.

53. The electronic compass system of claim 52, wherein said processing circuit computes second derivatives of the output signals from said compass sensor circuit, and wherein said processing circuit computes the noise level as a function of the mean square error of the computed second derivatives.

54. In a vehicle having a conductive glass windshield with an electrically conductive material incorporated therein and an electronic compass system having a magnetic sensor circuit located in proximity to the conductive glass windshield, the magnetic sensor circuit senses at least two components of the Earth's magnetic field vector and generates output signals representing the at least two sensed components, an improvement comprising:

a processing circuit coupled to the magnetic sensor circuit for sampling the output signals from the magnetic sensor circuit, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading; and

compensating means for compensating for the effect of an electric field caused by a conductive glass windshield on the magnetic field sensed by the magnetic sensor circuit.

55. The vehicle improvement of claim 54, wherein said compensating means comprises a controller for supplying a pulsed activation signal to the electrically conductive material incorporated in the conductive glass windshield when the conductive glass windshield is to be activated, the pulsed activation signal being pulsed between high and low power activation states, said controller supplies a signal to said processing circuit that identifies when the pulsed activation signal is in a low power activation state, wherein said processing circuit times the sampling of the output signals from the magnetic sensor circuit such that samples are not taken when the pulsed activation signal is in a low power activation state so as to prevent the reading of samples of the output signals of the magnetic sensor circuit when noise is produced by the conductive glass windshield.

56. The vehicle improvement of claim 54, wherein said compensating means comprises a coil provided in proximity to the compass sensor circuit to create a magnetic field that nulls a

magnetic field produced by the conductive glass windshield when the conductive glass windshield is activated.

57. The vehicle improvement of claim 54, wherein said compensating means comprises a pattern of conductive strips of the electrically conductive material of the conductive glass windshield, wherein at least adjacent first and second conductive strips extending in close proximity to the compass sensor circuit are patterned such that current passes through the first conductive strip in an opposite direction from the current passing through the adjacent second conductive strip so as to create magnetic fields that null one another.

58. The vehicle improvement of claim 54, wherein said compensating means comprises a pattern of very thin wires, wherein at least adjacent first and second wires extending in close proximity to the compass sensor circuit are positioned such that current passes through the first wire in an opposite direction from the current passing through the adjacent second wire so as to create magnetic fields that null one another.

59. The vehicle improvement of claim 54, wherein the electrically conductive material on the conductive glass window is provided in at least two portions and said compensating means comprises a window controller that periodically alternates the direction in which current is applied to the portions.

60. The vehicle improvement of claim 54, wherein said compensating means comprises a magnetic shielding coating placed between the conductive glass windshield and the compass sensor circuit.

61. The vehicle improvement of claim 54, wherein said compensating means comprises a monitoring circuit that monitors the output of the magnetic sensor circuit to identify rising and falling of levels of the output signals in a manner consistent with that caused by a magnetic field caused by the conductive glass windshield.

62. The vehicle improvement of claim 61, wherein the monitoring circuit prevents the sampling of the output signals by the processing circuit when such rising and falling of the levels of the output signals is identified.

63. The vehicle improvement of claim 61, wherein said monitoring circuit is a digital signal processor.

64. The vehicle improvement of claim 61, wherein said monitoring circuit is a portion of said processing circuit.

65. The vehicle improvement of claim 61, wherein said magnetic sensor circuit comprises three sensing elements for supplying three output signals representing three orthogonal components of the Earth's magnetic field, wherein said monitoring circuit monitors the output signals of all three of said sensing elements to identify rising and falling of levels of the output signals in a manner consistent with that caused by a magnetic field caused by the conductive glass windshield.

66. The vehicle improvement of claim 61, wherein said magnetic sensor circuit comprises two sensing elements for supplying two output signals representing two orthogonal components of the Earth's magnetic field, wherein said monitoring circuit monitors the output signals of both of said sensing elements to identify rising and falling of levels of the output signals in a manner consistent with that caused by a magnetic field caused by the conductive glass windshield.

67. The vehicle improvement of claim 61, wherein said processing circuit selects a first approximating geometric pattern based on a first set of reference data points derived from the sensed components, and computes a heading of the vehicle as a function of at least two of the sensed components while referencing the first approximating geometric pattern.

68. The vehicle improvement of claim 67, wherein said compensating means includes a portion of said processing circuit, wherein, during such time that said monitoring circuit identifies rising and falling of levels of the output signals in a manner consistent with that caused by a magnetic field caused by the conductive glass windshield, said portion of said processing circuit selects a second approximating geometric pattern based on reference data points received and utilizes the second approximating geometric pattern to compute the heading of the vehicle.

69. The vehicle improvement of claim 68, wherein during such time that said monitoring circuit does not identify rising and falling of levels of the output signals in a manner consistent with that caused by a magnetic field caused by the conductive glass windshield, said portion of said processing circuit utilizes the first approximating geometric pattern to compute the heading of the vehicle.

70. The vehicle improvement of claim 67, wherein said compensating means includes a portion of said processing circuit, wherein, during such time that said monitoring circuit identifies rising and falling of levels of the output signals in a manner consistent with that caused by a magnetic field caused by the conductive glass windshield, said portion of said processing circuit shifts the first approximating geometric pattern by an offset corresponding to a shift in the levels of the output signals caused by the conductive glass windshield when activated.

71. The vehicle improvement of claim 54, wherein said compensating means comprises a controller that activates the conductive glass windshield using a periodic activation signal having a predetermined frequency, wherein said processing circuit samples the output signals of the compass sensor circuit at twice the predetermined frequency of the activation signal, said processing circuit averages the samples of the output signals and subtracts any DC offset to eliminate the effect of the noise produced by the conductive glass windshield.

72. The vehicle improvement of claim 54, wherein the electrically conductive material incorporated within the conductive glass windshield is provided in the form of very thin wires. or transparent strips.

73. The vehicle improvement of claim 54, wherein the electrically conductive material incorporated within the conductive glass windshield is provided in the form of transparent strips.

74. The vehicle improvement of claim 54, wherein said compensating means immediately compensates for the effect of an electric field caused by a conductive glass windshield on the magnetic field sensed by the magnetic sensor circuit upon detection of the activation of the conductive glass windshield.

75. A method of mounting magnetic sensing elements on a circuit board, the method comprising:

mounting a first magnetic sensing element on a first portion of the circuit board;

mounting a second magnetic sensing element on a second portion of the circuit board;

bending the second portion of the circuit board to reorient the second magnetic sensing element relative to the first magnetic sensing element; and

securing the second portion of the circuit board relative to the first portion of the circuit board to retain the reoriented positions of the first and second magnetic sensing elements.

76. The method of claim 75 and further comprising mounting a third magnetic sensing element on the first portion of the circuit board.

77. The method of claim 76, wherein the third magnetic sensing element is mounted on the first portion of the circuit board substantially perpendicular to the first magnetic sensing element.

78. The method of claim 77, wherein the second magnetic sensing element is mounted on the second portion of the circuit board and reoriented so as to be substantially perpendicular to the first and third magnetic sensing elements.

79. The method of claim 75, wherein the second magnetic sensing element is mounted on the second portion of the circuit board and reoriented so as to be substantially perpendicular to the first magnetic sensing element.

80. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for:

receiving the output signals from said magnetic sensor circuit,

computing a heading of the vehicle as a function of the sensed components,

generating a heading signal representing the computed heading,

monitoring the output signals to identify changes in vehicle heading representing a vehicle turn of about 90 degrees,

storing the sensed components for those vehicle headings traveled immediately before and after any vehicle turn of about 90 degrees,

computing a variance of the stored sensed components from the four sets of values of the sensed components that the processing circuit had identified as corresponding to headings of north, south, east, and west, and

compensating the heading computation as a function of the computed variance.

81. The electronic compass system of claim 80, wherein said processing circuit stores the sensed components for those vehicle headings traveled immediately before and after any

vehicle turn of about 90 degrees if it is determined that the sensed components are within acceptable boundaries of other sensed components previously stored.

82. The electronic compass system of claim 80, wherein said processing circuit stores the sensed components for those vehicle headings traveled immediately before and after any vehicle turn of about 90 degrees if it is determined that the vehicle travels along these headings for at least predetermined time period.

83. An electronic compass system for a vehicle, comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector, and for generating output signals representing the at least two sensed components; and

a processing circuit coupled to said magnetic sensor circuit for receiving the output signals from said magnetic sensor circuit, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading, wherein said processing circuit determines in which of a plurality of geographic zones the vehicle is presently traveling, and compensates the heading computation as a function of geographic magnetic variance for the geographic zone in which the vehicle is presently traveling,

wherein said processing circuit determines in which geographic zone the vehicle is currently traveling by monitoring for changes in vehicle location relative to the plurality of geographic zones by monitoring vehicle headings and time of travel at each vehicle heading.

84. An electronic compass system for use in a vehicle having vehicle equipment consisting of one of a convertible top and sunroof, said electronic compass system comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector and generating output signals representing the at least two sensed components;

a processing circuit coupled to the magnetic sensor circuit for sampling the output signals from the magnetic sensor circuit, computing a heading of the vehicle as a function of

the sensed components, and generating a heading signal representing the computed heading; and

compensating means for compensating for the effect of a change in the opened or closed state of the vehicle equipment on the magnetic field sensed by the magnetic sensor circuit.

85. The electronic compass system of claim 84, wherein said compensating means comprises a monitoring circuit that monitors the output of the magnetic sensor circuit to identify changes in the levels of the output signals in a manner consistent with that caused by the opened or closed state of the vehicle equipment.

86. The electronic compass system of claim 85, wherein said monitoring circuit is a digital signal processor.

87. The electronic compass system of claim 85, wherein said monitoring circuit is a portion of said processing circuit.

88. The electronic compass system of claim 85, wherein said magnetic sensor circuit comprises three sensing elements for supplying three output signals representing three orthogonal components of the Earth's magnetic field, wherein said monitoring circuit monitors the output signals of all three of said sensing elements to identify changes in the levels of the output signals in a manner consistent with that caused by the opened or closed state of the vehicle equipment.

89. The electronic compass system of claim 85, wherein said magnetic sensor circuit comprises two sensing elements for supplying two output signals representing two orthogonal components of the Earth's magnetic field, wherein said monitoring circuit monitors the output signals of both of said sensing elements to identify changes in the levels of the output signals in a manner consistent with that caused by the opened or closed state of the vehicle equipment.

90. The electronic compass system of claim 85, wherein said processing circuit selects a first approximating geometric pattern based on a first set of reference data points derived from the sensed components, and computes a heading of the vehicle as a function of at least two of the sensed components while referencing the first approximating geometric pattern.

91. The electronic compass system of claim 90, wherein said compensating means includes a portion of said processing circuit, wherein, during such time that said monitoring circuit identifies changes in the levels of the output signals in a manner consistent with that caused by the opened or closed state of the vehicle equipment, said portion of said processing circuit selects a second approximating geometric pattern based on reference data points received and utilizes the second approximating geometric pattern to compute the heading of the vehicle.

92. The electronic compass system of claim 91, wherein during such time that said monitoring circuit does not identify changes in the levels of the output signals in a manner consistent with that caused by the opened or closed state of the vehicle equipment, said portion of said processing circuit utilizes the first approximating geometric pattern to compute the heading of the vehicle.

93. The electronic compass system of claim 90, wherein said compensating means includes a portion of said processing circuit, wherein, during such time that said monitoring circuit identifies changes in the levels of the output signals in a manner consistent with that caused by the opened or closed state of the vehicle equipment, said portion of said processing circuit shifts the first approximating geometric pattern by an offset corresponding to a shift in the levels of the output signals caused by the conductive glass windshield when activated.

94. The electronic compass system of claim 84, wherein said compensating means immediately compensates for the effect of an electric field caused by the opened or closed state of the vehicle equipment on the magnetic field sensed by the magnetic sensor circuit upon detection of an activation signal that causes the change in the opened or closed state of the vehicle equipment.

95. An electronic compass system for use in a vehicle having at least one vehicle accessory capable of adversely effecting the operation of the compass system, said electronic compass system comprising:

a magnetic sensor circuit for sensing at least two components of the Earth's magnetic field vector and generating output signals representing the at least two sensed components;

a processing circuit coupled to the magnetic sensor circuit for sampling the output signals from the magnetic sensor circuit, computing a heading of the vehicle as a function of the sensed components, and generating a heading signal representing the computed heading; and

wherein said processing circuit immediately compensates for the effect of the vehicle accessory on the magnetic field sensed by the magnetic sensor circuit upon detection of the effect of the vehicle accessory on the magnetic field without requiring a signal from the vehicle accessory.

96. The electronic compass system of claim 95, wherein said compensating means comprises a monitoring circuit that monitors the output of the magnetic sensor circuit to identify changes in the levels of the output signals in a manner consistent with that caused by the vehicle accessory.

97. The electronic compass system of claim 96, wherein said monitoring circuit is a digital signal processor.

98. The electronic compass system of claim 96, wherein said monitoring circuit is a portion of said processing circuit.

99. The electronic compass system of claim 96, wherein said magnetic sensor circuit comprises three sensing elements for supplying three output signals representing three orthogonal components of the Earth's magnetic field, wherein said monitoring circuit monitors

the output signals of all three of said sensing elements to identify changes in the levels of the output signals in a manner consistent with that caused by the vehicle accessory.

100. The electronic compass system of claim 96, wherein said magnetic sensor circuit comprises two sensing elements for supplying two output signals representing two orthogonal components of the Earth's magnetic field, wherein said monitoring circuit monitors the output signals of both of said sensing elements to identify changes in the levels of the output signals in a manner consistent with that caused by the vehicle accessory.

101. The electronic compass system of claim 96, wherein said processing circuit selects a first approximating geometric pattern based on a first set of reference data points derived from the sensed components, and computes a heading of the vehicle as a function of at least two of the sensed components while referencing the first approximating geometric pattern.

102. The electronic compass system of claim 101, wherein said compensating means includes a portion of said processing circuit, wherein, during such time that said monitoring circuit identifies changes in the levels of the output signals in a manner consistent with that caused by the vehicle accessory, said portion of said processing circuit selects a second approximating geometric pattern based on reference data points received and utilizes the second approximating geometric pattern to compute the heading of the vehicle.

103. The electronic compass system of claim 102, wherein during such time that said monitoring circuit does not identify changes in the levels of the output signals in a manner consistent with that caused by the vehicle accessory, said portion of said processing circuit utilizes the first approximating geometric pattern to compute the heading of the vehicle.

104. The electronic compass system of claim 101, wherein said compensating means includes a portion of said processing circuit, wherein, during such time that said monitoring circuit identifies changes in the levels of the output signals in a manner consistent with that caused by the vehicle accessory, said portion of said processing circuit shifts the first

approximating geometric pattern by an offset corresponding to a shift in the levels of the output signals caused by the vehicle accessory when activated.

105. The electronic compass system of claim 95, wherein said compensating means immediately compensates for the effect of an electric field caused by the opened or closed state of the vehicle equipment on the magnetic field sensed by the magnetic sensor circuit upon detection of the activation of the change in the vehicle accessory.

106. The electronic compass system of claim 96, wherein said monitoring circuit monitors the voltage of the vehicle's battery and monitors the output of the magnetic sensor circuit to identify changes in the levels of the output signals in a manner consistent with that caused by the vehicle accessory taken as a function of the voltage of the vehicle's battery.